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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

HIGH-FREQUENCY ACOUSTIC RECORDING PACKAGE
DATA SUMMARY REPORT
PS09, FEBRUARY 26, 2010–NOVEMBER 03, 2010

by

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October 2012

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14. ABSTRACT
This summary continues a series of reports on marine mammal vocalizations in the High-Frequency Acoustic Recording Package (HARP, Wiggins and Hildebrand, 2007) data collected by the NPS Oceanography Department off Point Sur beginning in October 2006. The present report provides an initial summary of marine mammal vocalizations detected and identified in records from the ninth (PS09) HARP deployment between February 26, 2010 and November 03, 2010. Data were acquired in the 10 Hz – 100 kHz frequency band at a 200 kHz sampling frequency for 5 minutes during each 25 minutes. Long-term spectral averages were created for three frequency bands (10 Hz–1000 Hz, 1 kHz–5 kHz, 5 kHz–100 kHz) and then scanned for marine mammal vocalizations. Detected calls of blue whales, fin whales, humpback whales, as well as echolocations of sperm whales, beaked whales, and dolphins are presented as occurrence time diagrams.

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Marine mammals, passive acoustic monitoring, HARP, long-term spectral average, baleen whales, odontocetes, blue whales, fin whales, humpback whales, sperm whales, Pacific white-sided dolphins, Risso's dolphins

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ABSTRACT

This summary continues a series of reports on marine mammal vocalizations in the High-Frequency Acoustic Recording Package (HARP, Wiggins and Hildebrand, 2007) data collected by the NPS Oceanography Department off Point Sur beginning in October 2006. The present report provides an initial summary of marine mammal vocalizations detected and identified in records from the ninth (PS09) HARP deployment between February 26, 2010 and November 03, 2010. Data were acquired in the 10 Hz – 100 kHz frequency band at a 200 kHz sampling frequency for 5 minutes during each 25 minutes. Long-term spectral averages were created for three frequency bands (10 Hz–1000 Hz, 1 kHz–5 kHz, 5 kHz–100 kHz) and then scanned for marine mammal vocalizations. Detected calls of blue whales, fin whales, humpback whales, as well as echolocations of sperm whales, beaked whales, and dolphins are presented as occurrence time diagrams.

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I. DATA

The PS09 HARP was deployed on top of Sur Ridge at 36º23.479´N, 122º18.450´W on February 25, 2010 (recording started on February 26, 2010) and recovered on November 03, 2010. The instrument location is shown in Fig. 1. Bottom depth at the deployment site was about 837 m. A schematic diagram of the PS09 HARP mooring (courtesy of Ms. Marla Stone, Naval Postgraduate School) is given in Fig. 2. Temperature, salinity, and current data collected on the mooring will be described in a separate report.

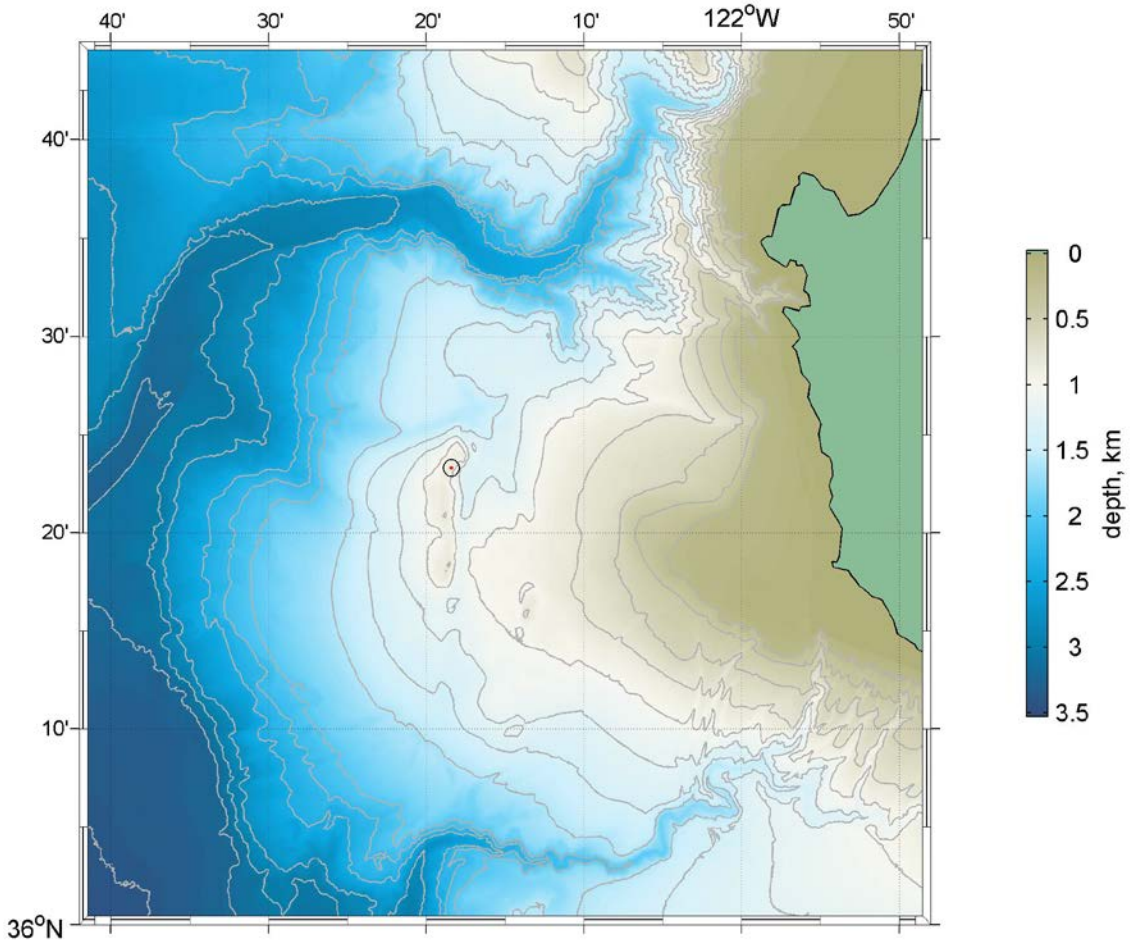

Figure 1. Chart showing PS09 HARP deployment location (red dot) to the west of Point Sur, California. The scale to the right indicates bottom depth in kilometers. Isobaths (gray lines) are shown at 200 m interval.

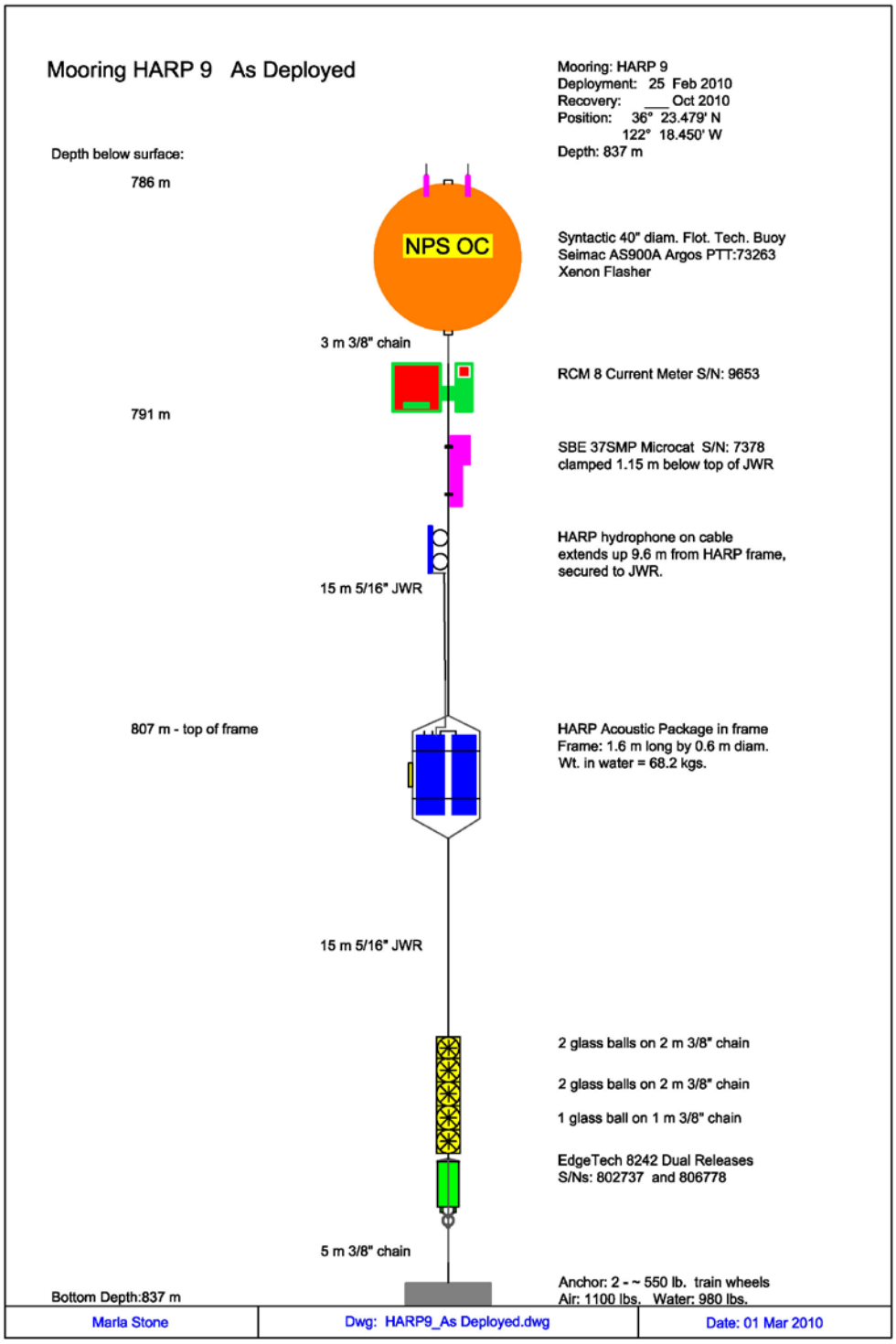

Figure 2. Schematic diagram showing details of the PS09 HARP. Note that objects and distances are not drawn to scale.

Data were acquired at a 200 kHz sampling frequency for 5 minutes during each 25 minutes. The PS09 HARP deployment provided a total of 1204 hours of data over the 251 days of recording (see Fig. 3).

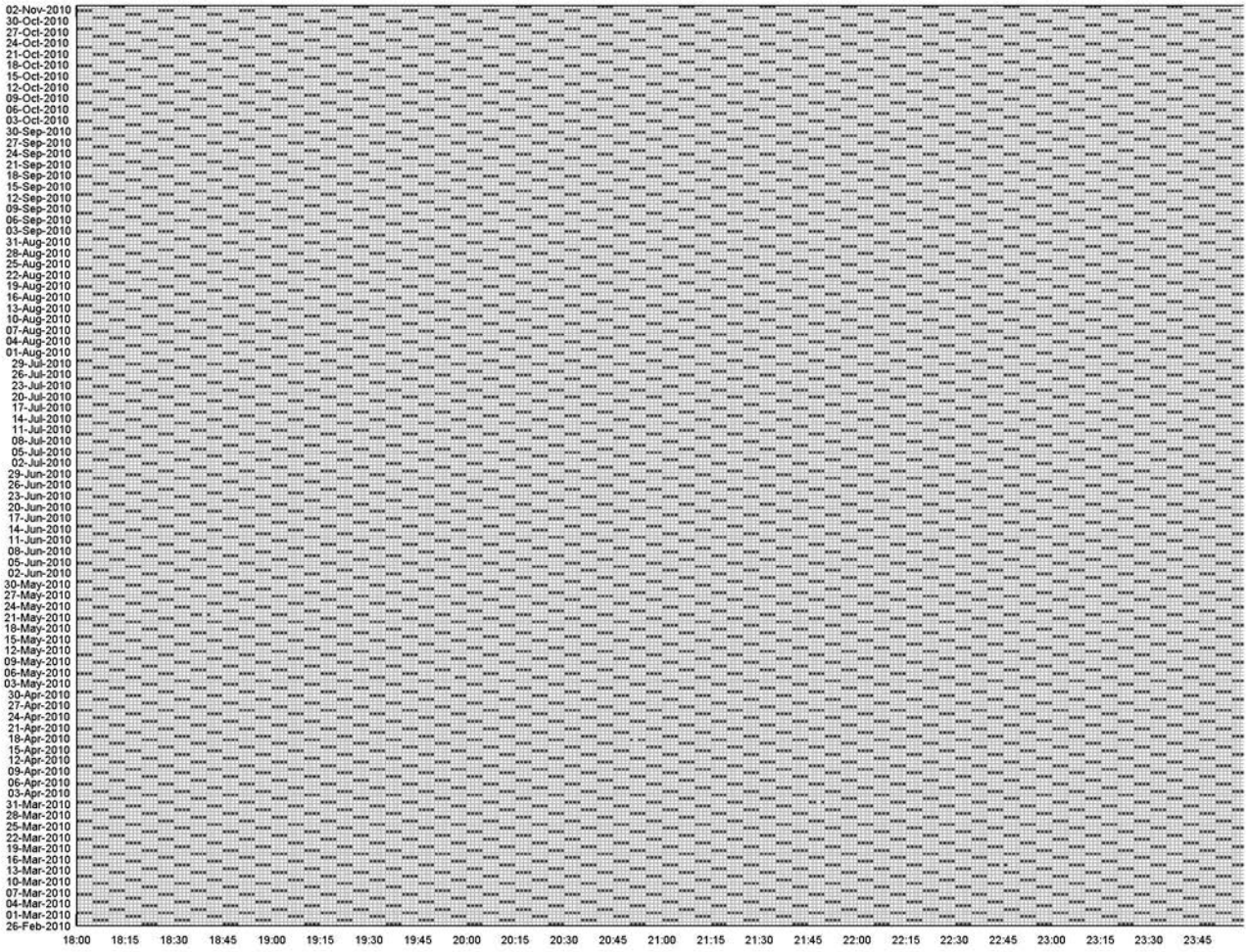

Figure 3. PS09 HARP schedule from 06:00:00 PM to 11:58:45 PM of each day. Each cell corresponds to one raw file of 75 s duration.

The PS09 HARP data were manually scanned for marine mammal vocalizations using the "logger" version of the Scripps *Triton* software (v1.7b.20100426_loggers) as described in Technical report # NPS-OC-10-003 "High Frequency Automatic Recording Package Data Summary Report PS05, August 4, 2008 – January 6, 2009" (available online at http://edocs.nps.edu/npspubs/scholarly/TR/2010/NPS-OC-10-003.pdf).

II. RESULTS

Table 1 summarizes detected and identified marine mammal vocalizations for the PS09 HARP deployment. Figs. 4–10 illustrate occurrence patterns for different species and call types in 75 s bins.

Occurrence rate for the marine mammals identified in 2010 Pt. Sur HARP recordings was higher than in 2009 and — for some species — in 2008 (see also Technical Reports ## NPS-OC-10-003, NPS-OC-11-002, NPS-OC-11-003).

Fin whales were present throughout the PS09 deployment with maximum occurrence rate in July–November 2010 (Fig. 4). For fin whales, 2009 and 2010 occurrence rates were comparable and higher than in 2008. The observed fin whale calls were mostly 20 Hz calls.

Blue whales were present starting in August with continuous (as one can conclude from a scheduled recording) occurrence in September–October 2010 (Fig. 5). The blue whale vocalizations consisted of A and B calls, either as songs or individual calls, as well as several D calls associated with foraging. See also Table 1.

Humpback whales were present from February till November, with higher occurrence rate in 2010 than in 2008-2009. Occurrence of humpback whale songs had bi-modal annual structure: continuous presence in September–October and secondary peak in March–April (Fig. 6).

Sperm whale clicks were present mostly from March to June (Fig. 7) and at evidently higher occurrence rate in 2010.

Detected dolphin vocalizations included echolocation clicks, whistles, and burst pulses (Figs. 8–10). Dolphins were present throughout the PS09 deployment, about 70% of them identified as Pacific white-sided dolphins, which intensified during night time from March to September 2010 (Fig. 7). Risso's dolphins were detected mostly in May–June 2010 (Fig. 9). Risso's dolphin occurrence rate was higher in 2010; 2010 Pacific white-sided dolphin occurrence rate was comparable to 2009 one and higher than in 2008.

Sparse beaked whale vocalizations were present in PS09 records.

Table 1. Summary of identified marine mammal vocalizations.

Species	Call type	Hours of vocalizations	Percentage of total deployment duration (in hours)	Days with vocalizations	Percentage of total deployment duration (in days)
Fin whale	20 Hz	815	16%	104	41%
Blue whale	various	3435	57%	38	15%
Blue whale	A call	1967	33%	38	15%
Blue whale	B call	1429	24%	19	8%
Blue whale	D call	40	<1%	10	4%
Humpback whale	Song	2417	40%	119	47%
Sperm whale	echolocation	302	25%	55	22%
Beaked whale (total)	echolocation	6	<1%	21	8%
Dolphins (total)	echolocation/ whistles	1407	23%	222	88%
Risso's dolphin	echolocation	78	1%	33	13%
Pacific white-sided dolphin	echolocation/ whistles	864	14%	170	68%
Unidentified dolphin	echolocation/ whistles	465	8%	181	72%

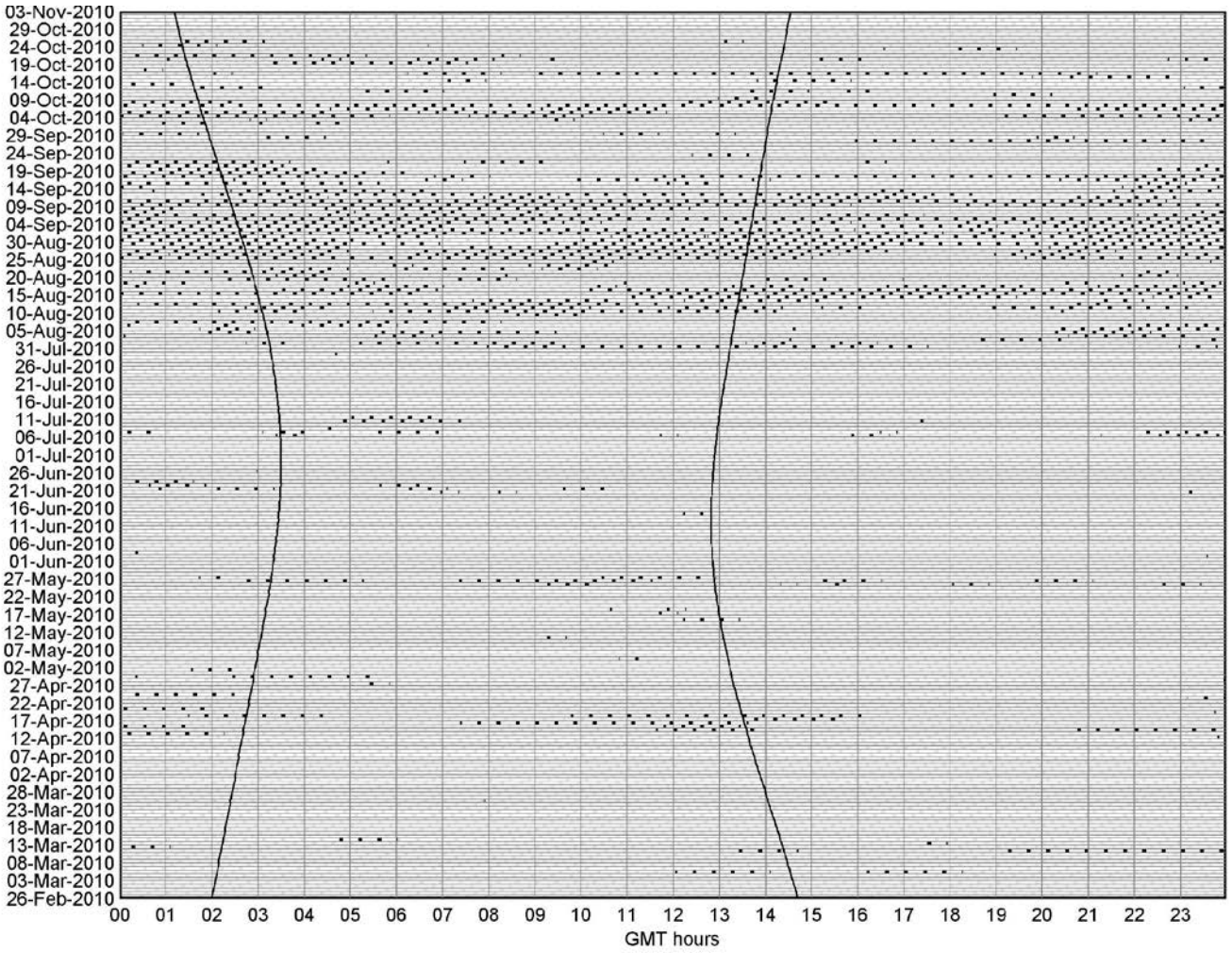

Figure 4. Fin whale calls in 75 s bins.

Solid lines mark sunset (left) and sunrise (right).

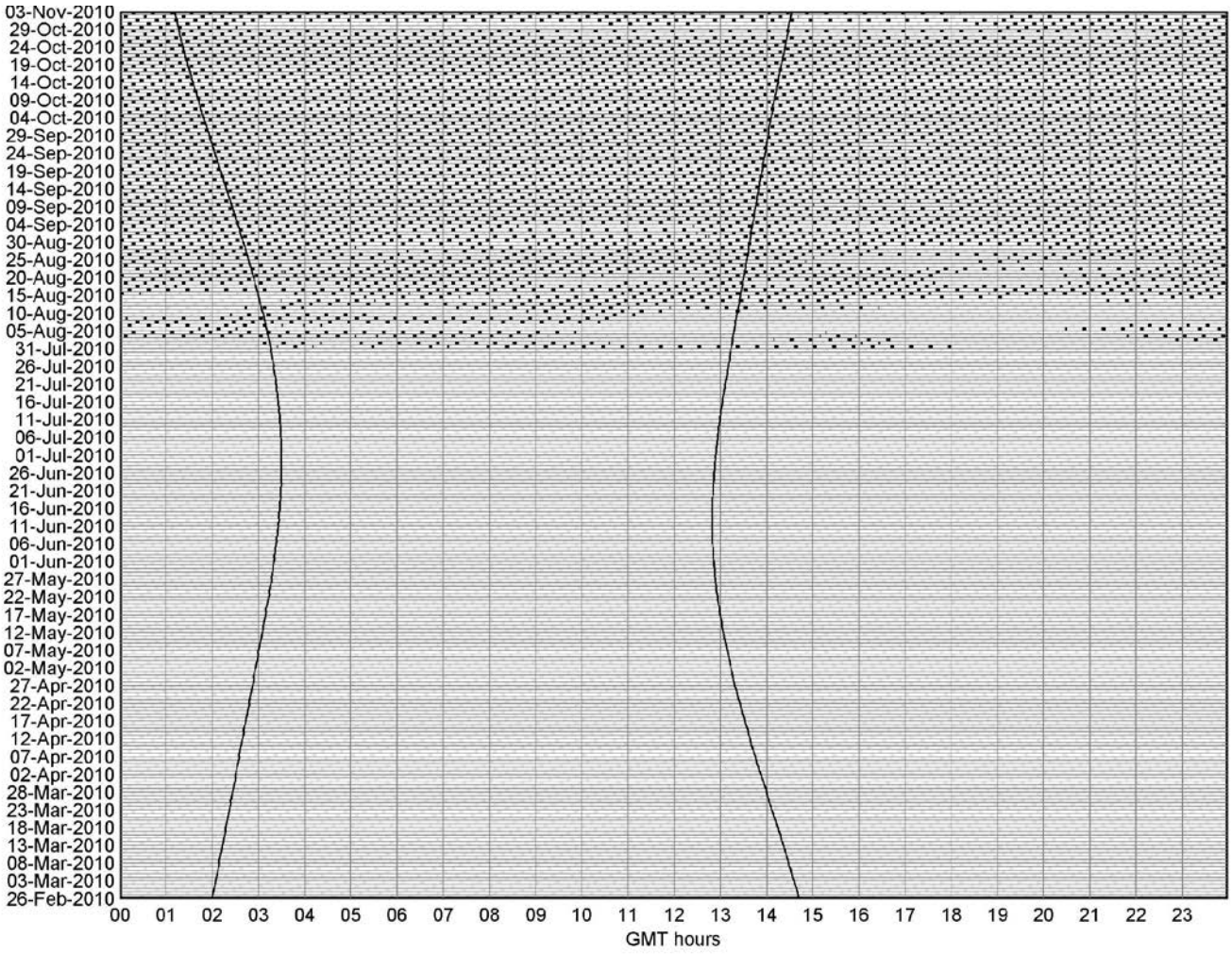

Figure 5. Blue whale vocalizations in 75 s bins. Solid lines mark sunset (left) and sunrise (right).

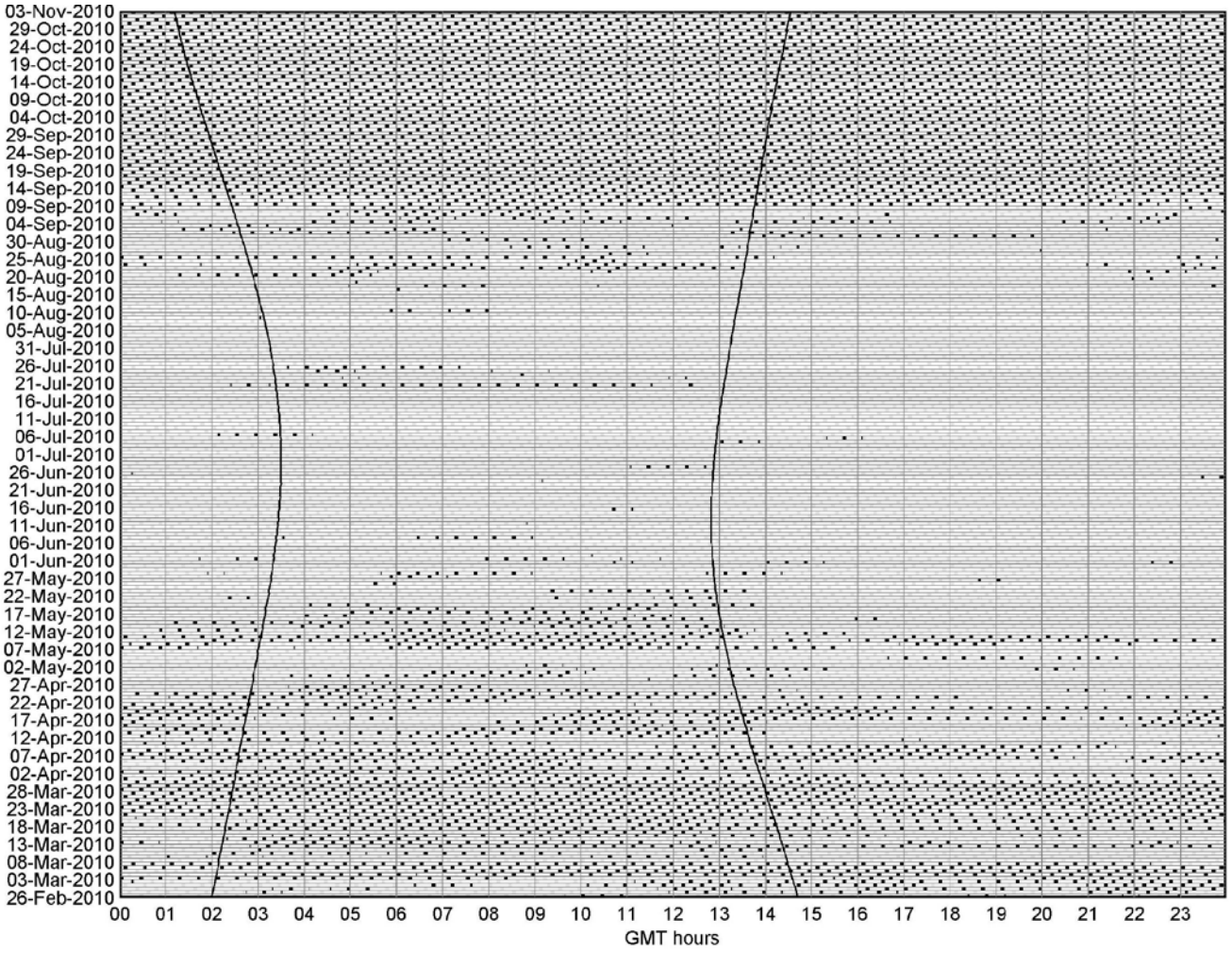

Figure 6. Humpback whale vocalizations in 75 s bins.
Solid lines mark sunset (left) and sunrise (right).

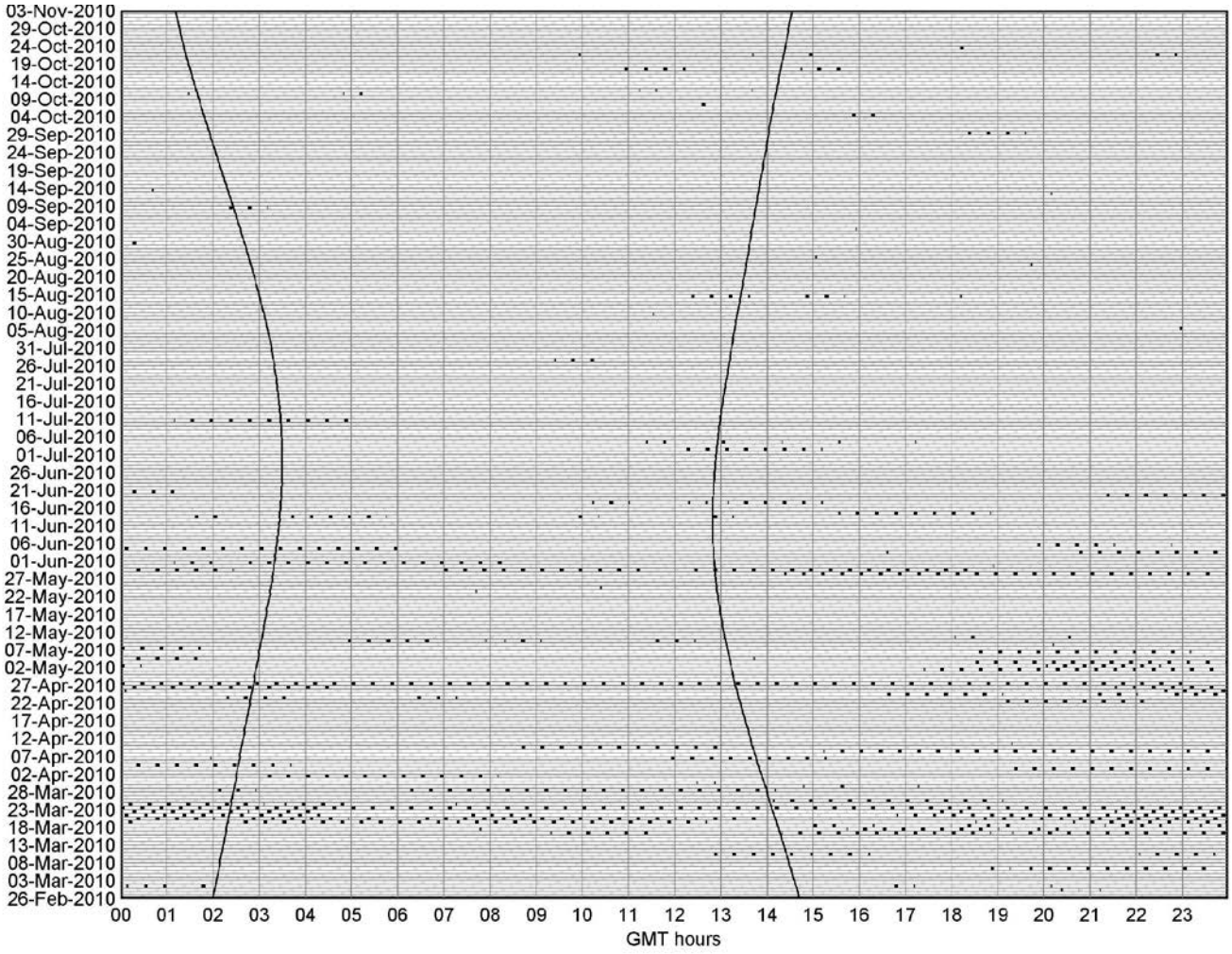

Figure 7. Sperm whale echolocation clicks in 75 s bins.
Solid lines mark sunset (left) and sunrise (right) timing.

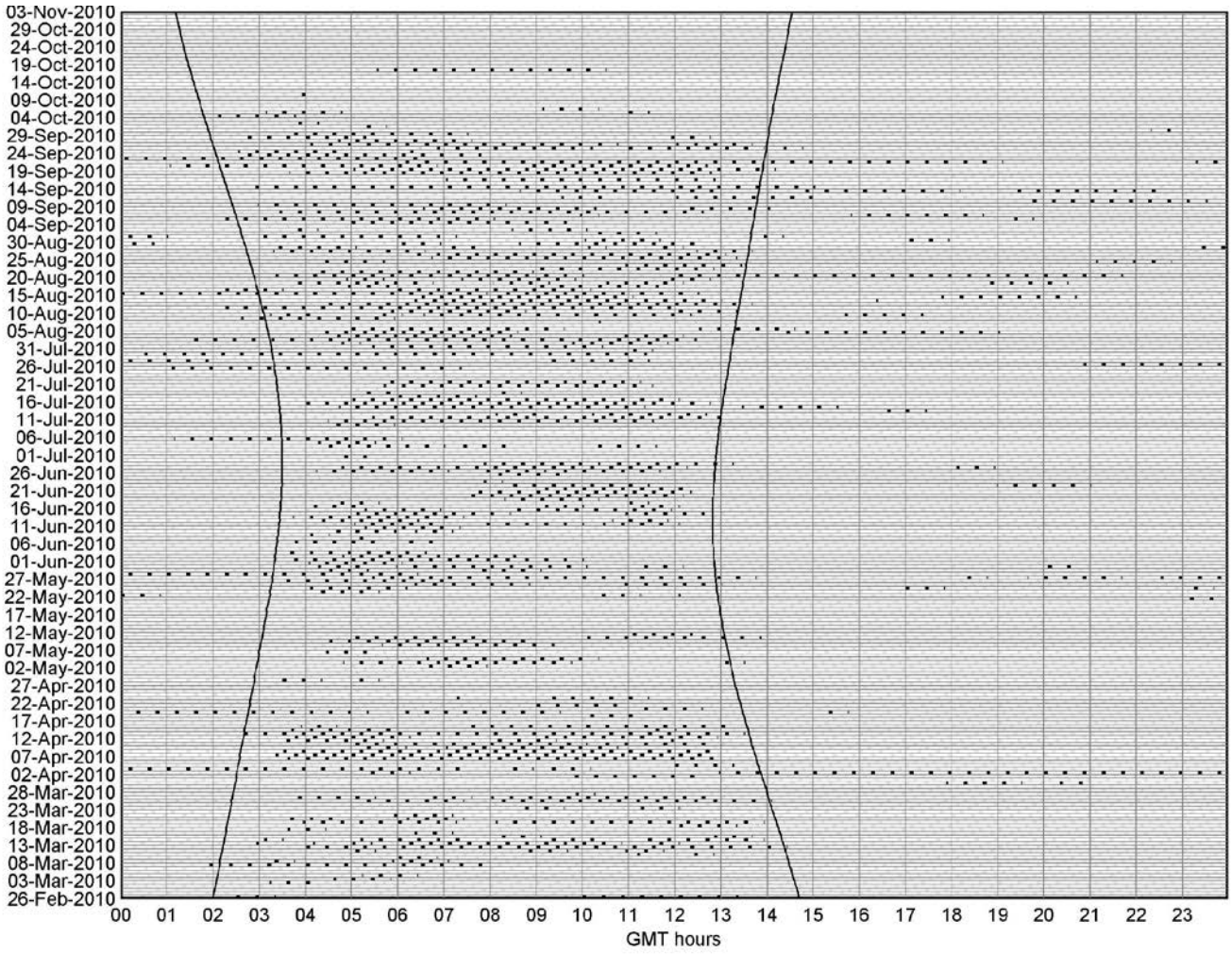

Figure 8. Echolocation clicks of Pacific white-sided dolphin in 75 s bins. Solid lines mark sunset (left) and sunrise (right) timing.

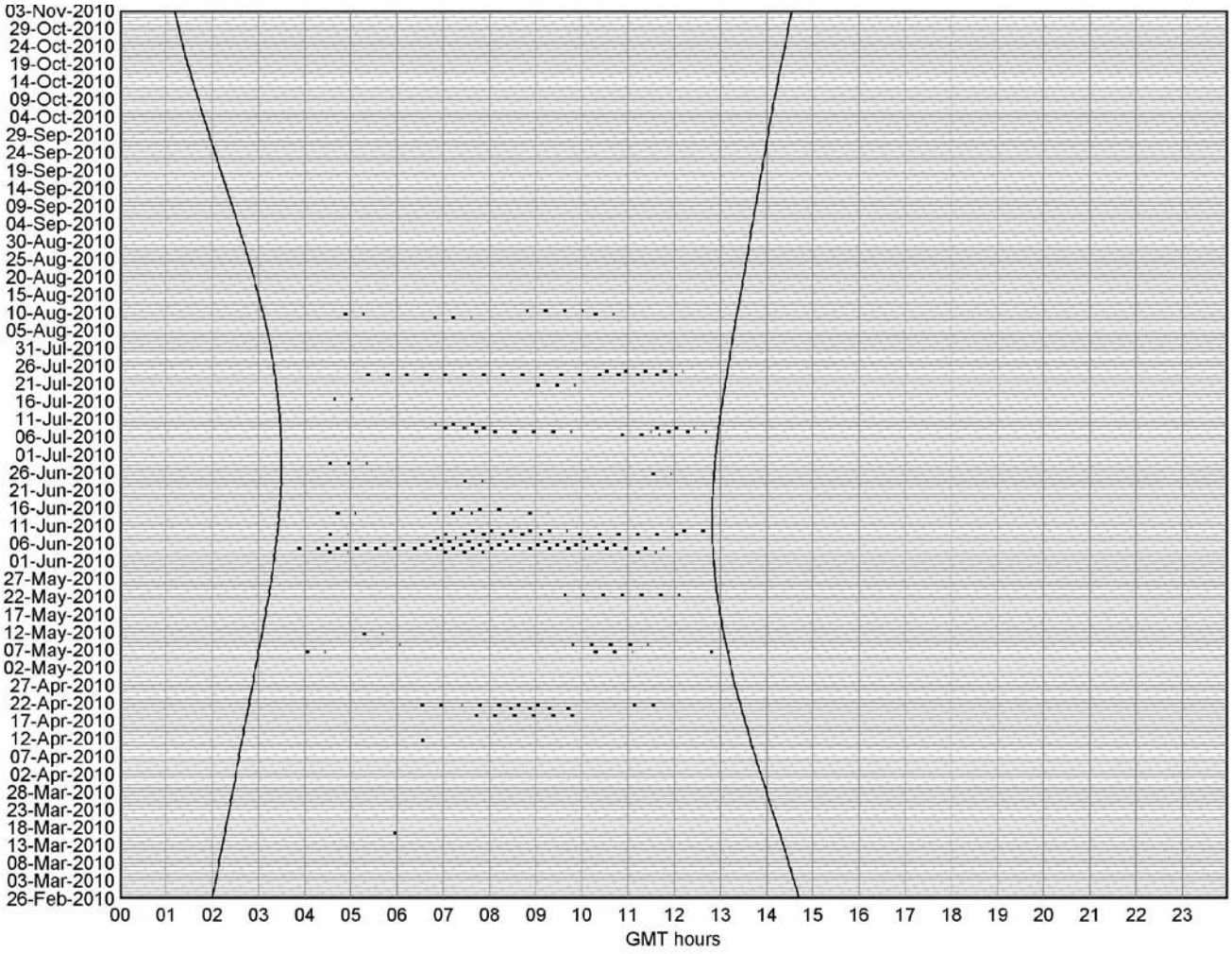

Figure 9. Risso's dolphin echolocation clicks in 75 s bins.
Solid lines mark sunset (left) and sunrise (right).

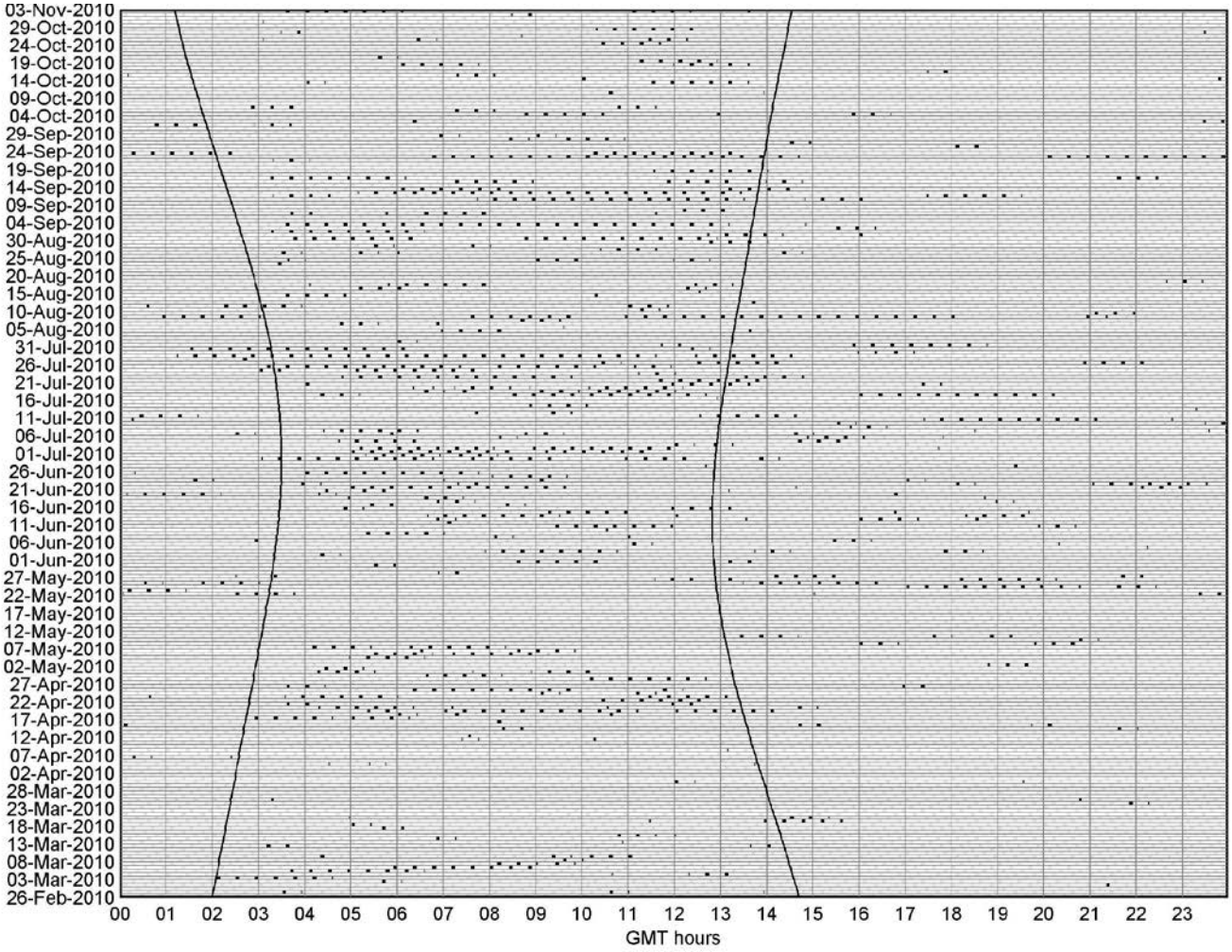

Figure 10. Echolocation clicks and whistles of unidentified dolphins in 75 s bins. Solid lines mark sunset (left) and sunrise (right) timing.

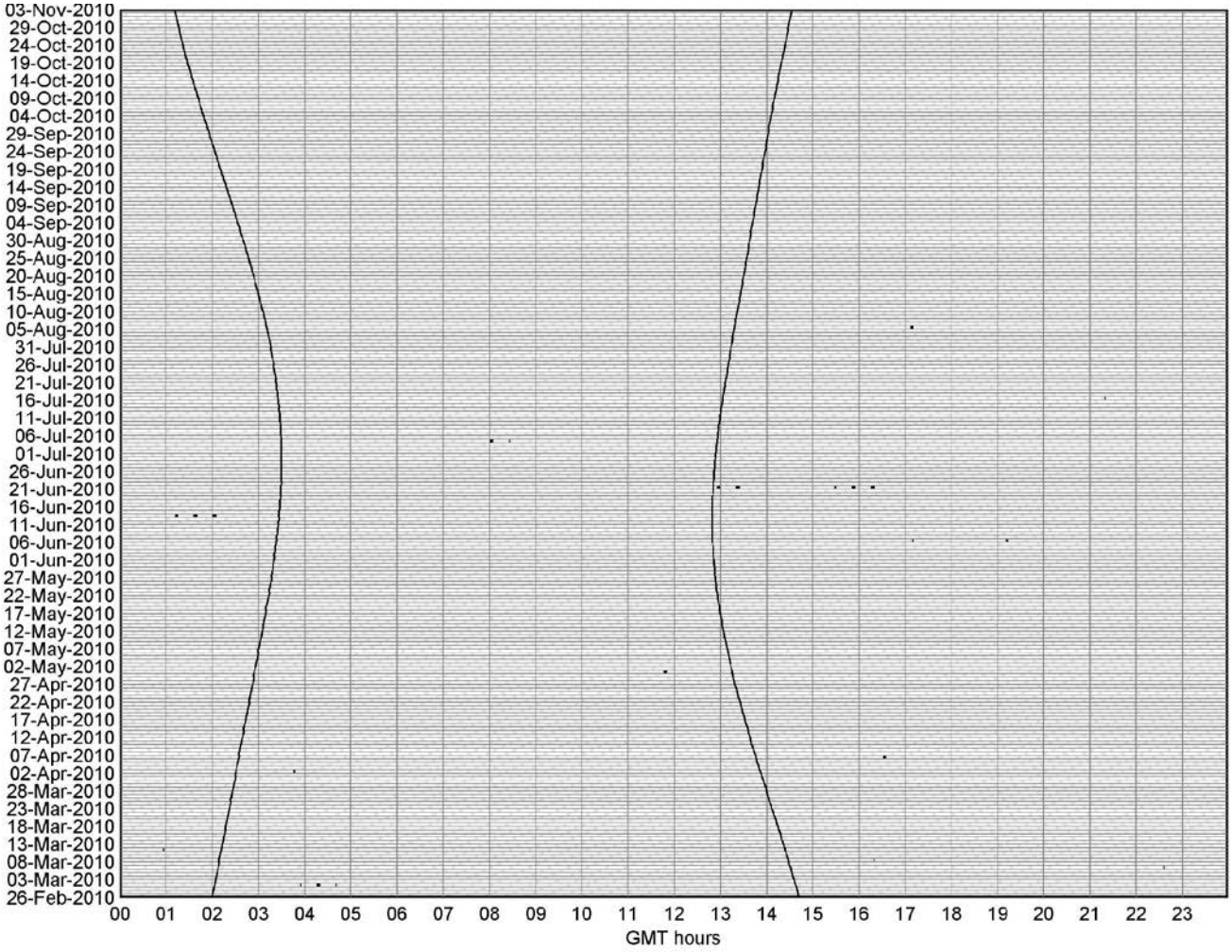

Figure 11. Beaked whale echolocation clicks in 75 s bins.
Solid lines mark sunset (left) and sunrise (right) timing.

LIST OF REFERENCES

Wiggins, S. M., and J. A. Hildebrand, 2007: High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring. *International Symposium on Underwater Technology 2007 and International Workshop on Scientific Use of Submarine Cables & Related Technologies 2007*, UT07, 551 - 557.

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